

M7	Lesson #2	Percent , ppm and ppb	Lesson #1	Lesson #3
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**Topics****Calculating Concentrations****Molarity****Percent, ppm and ppb.****Dilution****Standard Solutions****Percent, Parts per million (PPM) and Parts per billion (ppb) calculations**

**Molarity** is the most commonly used measure of concentration by chemists in the laboratory, due to it's direct relationship with chemical equations. Industry and society however do use other measures of concentrations.

**Percent concentration** is common in calculations of drug concentration and other chemicals used in homes. Vinegar for example is 7% acetic acid. Hydrogen peroxide solutions are 3%  $\text{H}_2\text{O}_2$ .

To calculate very small concentration measures like **Parts per million(ppm)**, or **Parts per billion(ppb)** are used in industry.

**Similarities in calculations**

The calculations using measures of percent, ppm and ppb also use the same ratio of solute to solvent used in molarity.

$$\text{Concentration} = \frac{\text{Amount of solute}}{\text{Amount of solvent}}$$

**Differences in calculations**

The differences in how these concentrations are calculated are :

1. The units used to measure amount of solute and solvent.
2. The constant factor that is used to multiply the ratio:
  - o Percent multiply by hundred. ( $10^2$ ).
  - o Parts per million multiply by million ( $10^6$ ).
  - o Parts per billion multiply by a billion ( $10^9$ ).

**A) Percent concentration**

Percent concentration always multiplies the ratio of solute to solvent by 100. Variations of percent concentrations depend on which **unit is used to measure the amount of solute or solvent**.

- If mass is used the concentration is called weight by weight or (W/W)
- If volume is used for the solvent then the ration is weight by volume (W/V)

The formula used to calculate percent concentration is

$$\frac{\text{Concentration}}{100} = \frac{\text{Amount of solute}}{\text{Amount of solvent}}$$

Notice that the formula is a proportion and the missing parts of the formula can be solved by cross multiplying the extremes by the means.

[Top of Page](#)

**Examples (% concentration)****Example:**

Calculate the percent weight by volume percent concentration of a solution in g/ml is 35 grams of salt is dissolved in 0.140 L of water.

**1) List the given information:**

35 grams of salt  
0.140L

**2) Determine the required information:**

% concentration in g/ml

**3) Solve for concentration:**

a) convert liters to milliliters

$$0.140 \text{ L} = 140 \text{ ml}$$

b) plug into formula and calculate

Concentration		35 grams
	=	
100		140 ml

$$\text{Concentration} = 25 \%$$

**Check your understanding**

What volume of water, in milliliters, that needs to be added to 120 grams of NaCl (s) to produce a 5.0 % solution (W/V) that could be used as a mouthwash.

*click the eye to view answer*

[Top of Page](#)

**B) Parts per million (ppm) and Parts per billion (ppb)**

The only difference in the calculations of parts per million and parts per billion is factor used to multiply the ratio. The formulas for these two are:

**Parts per million**

$$\frac{\text{Concentration}}{1,000,000} = \frac{\text{Amount of solute}}{\text{Amount of solvent}}$$

**Parts per billion**

$$\frac{\text{Concentration}}{1,000,000,000} = \frac{\text{Amount of solute}}{\text{Amount of solvent}}$$

**1,000,000,000****Amount of solvent**

The calculations are done in exactly the same way as the percent calculations above . Keep in mind two ideas when doing these calculations

**Note:**

1. These calculations are usually weight by weight calculations and the units of mass must be the same for both solute and solvent.
2. To help identify the solute from the solvent , keep in mind that the solvent is the substances doing the dissolving and in any mixture is the larger portion.

[Top of Page](#)

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**Examples and Assignments****Check your understanding**

Calculate the mass in grams of selenium in a body if the body weights 50 Kg and the concentration is 4.0 ppm



*click the eye to view the answer*

**Assignment:** Calculation with Percent, ppm and ppb.

**Check your understanding**

Calculate the mass in grams of selenium in a body (solute) if the body weights 50 Kg and the concentration is 4.0 ppm.

1) List the given

mass of body (solvent) = 50 Kg  
concentration = 4.0 ppm

2) Determine the required information

Calculate the mass of selenium in grams

3) Using formula solve to mass

a) Units of mass of the solute and solvent must be the same

50 Kg = 50,000 grams

b) Plug information into formula

<b>Concentration (ppm)</b>		<b>Amount of solute</b>
	=	
<b>1,000,000</b>		<b>Amount of solvent</b>

<b>4.0</b>		<b>Amount of solute</b>
	=	
<b>1,000,000</b>		<b>50,000</b>

**Amount of Solute (grams) = 0.2 grams of selenium.**